FOR 2 –YEAR PG PROGRAMME IN INDUSTRIAL MICROBIOLOGY

Scheme B-1 (For Courses of Science & Arts Discipline having Major Practicum Component)

Year / Semester		Course Type				Total Credits
		Course Level	**Core Courses/ Dissertation**	**Practicum Courses**	**Internship/Apprenticeship/Seminar OR VAC** (CHM/EESC)	
First Year	**Sem-I**	400	CC-11 (6 Credits) Cell biology & Biochemistry of Microorganisms	PC-11 (4 Credits) Practical based on- Cell biology & Biochemistry of Microorganisms	Internship/Apprenticeship ***OR*** Seminar (2 Credits)	**22**
		400	CC-12 (6 Credits) Microbial Metabolism & Physiology	PC-12 (4 Credits) Practical based on- Microbial Metabolism & Physiology		
	Sem-II	400	CC-21 (6 Credits) Analytical techniques in Microbiology	PC-21 (4 Credits) Practical based on- Analytical techniques in Microbiology	VAC (CHM/EESC) (2 Credits)	**22**
		400	CC-22 (6 Credits) Fermentation Technology	PC-22 (4 Credits) Practical based on- Fermentation Technology		

Note: Students who exit at the end of 1 " year shall be awarded a postgraduate Diploma.

OPTION- 1: Only Course Work
(Applicable to the UTDs/Colleges)

Year / Semester		Course Level	Core Courses/ Dissertation	Practicum Courses	Internship/Apprenticeship/Seminar OR VAC (CHM/EESC)	Total Credits
Second Year	**Sem-III**	500	CC-31 (6 Credits) Industrial Production processes	PC-31 (4 Credits) Practical based on- Industrial Production processes	Internship/Apprenticeship ***OR*** Seminar (2 Credits)	**22**
		500	CC-32 (6 Credits) Bioprocess technology & Biosafety	PC-32 (4 Credits) Practical based on- Bioprocess technology & Biosafety		
	Sem-IV	500	CC-41 (6 Credits) Microbial Biotechnology	PC-41 (4 Credits) Practical based on- Microbial Biotechnology	VAC (CHM/EESC) (2 Credits)	**22**
		500	CC-42 (6 Credits) Genomics, Bioinformatics & Biostatistics	PC-42 (4 Credits) Practical based on- Genomics, Bioinformatics & Biostatistics		

OPTION- 2: Course Work & Research Work

(Applicable to the UTDs/Colleges having research centers recognized by the University)

Year / Semester		Course Level	Core Courses/ Dissertation	Practicum Courses	Internship/Apprenticeship/Seminar OR VAC (CHM/EESC)	Total Credits
Second Year	Sem-III	500	CC-31 (6 Credits) Industrial Production processes	PC-31 (4 Credits) Practical based on- Industrial Production processes	Seminar (2 Credits)	22
		500	CC-32 (6 Credits) Bioprocess technology & Biosafety	PC-32 (4 Credits) Practical based on- Bioprocess technology & Biosafety		
	Sem-IV	-	-	-	Research thesis/Project/Patent (22 Credits)	22

OPTION- 3: Only Research Work

(Applicable to the UTDs/Colleges having research centers recognized by the University

Second Year	Sem-III	Research thesis/Research Project/Patent (22 Credits)	22
	Sem-IV	Research thesis/Research Project/Patent (22 Credits)	22

Note: (1) UTDs/Colleges with Research Centers have the choice of running all the OPTION mentioned above.

(2) Students having 4 –Year Under Graduate Degree (Honours/Honours with Research) are eligible for entry in the Semester –I of I-year PG Programme.

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG programme/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-I)/ Second Year (Semeter-III)	Session: 2025-26/ 2025-27
Subject: Industrial Microbiology				
1	Course Code	CC - 31		
2	Course Title	Industrial Production processes		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours/ research level degree programme/ PG first year.		
5	Course Learning outcomes (CLO)	On successfully completing the module, students will be able to demonstrate a knowledge and understanding of: • **Patent laws and patent types, procedures for patent filing.** • **Concept of Intellectual property rights, commercialization of any inventions in the biotechnology sector.** • **Antibiotics types, range and production of different types of antibiotics.** • **Development and production of various kinds of vaccines, vitamins and proteins.** • **Use of microbes in various fermented food products for human consumption. Finally the students will learn the use of microbes in the production of alcoholic beverages.**		
6	**Credit Value**	**06**		
7	**Total Marks**	Max. Marks: 40+60	Min. Passing Marks:40	

Part B- Content of the Course		
Total No. of Lectures- (90 hours): L-T-P:		
Unit	Topics	No. of Lectures (in Hrs)
I	1.1 Indian patenting system in Microbiology. Ethanomicrobiology, Fermentation products viz. Dahi, Mistri, Kinema, Dhokla etc. 1.2 Biotransformation, Microbial production of polymers etc. 1.3 Bioelectronics, Biotransformation, IPR and IPP 1.4 Microbial Production of Polymers, Dextran and xanthan. 1.5 Bioelectronics: Biochips and Biosensors	18
II	2.1 Microbial Industrial Production, Industrial Production of organic acid: Citric acid, lactic acid and glutamic acid. 2.2 Industrial production of Enzymes: Amylase and Protease. enzyme immobilization and application. 2.3 Industrial production of solvent: acetone, Ethanol, Butanol, Glycerol. 2.4 Industrial production of Vitamins: Vitamin B2 and B12, Riboflavin. 2.5 Industrial production of Antibiotics: Penicillin and Streptomycin. Classification of antibiotics.	18
III	3.1 Microbial Production of Amino acids, Beverages, Vaccines and Steroids. 3.2 Production of amino acids: Lysine and Valine. 3.3 Non-alcoholic beverages: Steps of distillation Plants of Tea and Coffee 3.4 Microorganism used in Alcoholic Fermentation (Beverages): Beer, Rum, Wine, Gin, Whiskey, Brandy etc. 3.5 Steroids: microbial transformation of steroids and important vaccines and their production.	
IV	4.1 Microorganism used in production of fuel. 4.2 Fermentation conditions required for production of fuels, recovery and use of Hydrogen ethanol, Biogas and biodiesel. 4.3 Production of SCP (single Cell Protein.) algae, Bacteria and actinomycetes, Microbial organism used in production of single cell protein. 4.4 Mushroom production: types, production and harvesting. 4.5 Production of Bio fertilizers and production of bio pesticides.	18

25/6/25

V	5.1 Immobilization and production processes of Enzymes. 5.2 Immobilization of enzymes and microbial cells: Methods of Immobilizations changes in kinetic pattern after Immobilization, whole cell Immobilization. 5.3 Industrial application of immobilized enzymes and cells. 5.4 Production process of Enzymes: Amylases and Pectinases, Protease. 5.5 Hygiene and safety in industrial production processes.	18

Activities:

- *Quiz competition of various aspect of industrial fermentation products.*
- *Listing charts of different fermentation process*
- *Industrial visit/ field visit to observe different types of fermenter*
- *Preparation of charts and models related to modules*
- *Registration of Virtual labs for activities related to modules from different web labs.*

Keywords/Tags: *Industrial production, biotransformation, organic acids, enzymes, single cell protein.*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering.New York: M. Dekker.
4. Bailey, J. E., &Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
5. Prescott, S.C. and C.G. Dunn (2012) Industrial microbiology (McGraw- Hill).
6. R. Y. Stanier, I.Ingraham, M.L.Wheller and P.R.Painter (2008). General microbiology (MacMillian Press London).
7. Pommervillie and Jeffery C.(2011) Alcamo's Fundamentals of Microbiology (Jones & Barttlet London)
8. L.E.Casida (2010) Industrial Microbiology (New age Publication, New Delhi)

2. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

Syllabus of Practicum Course

Part A Introduction			
Program: 1 year PG programme/ 2 year PG Programme	Class`: M Sc	Year: First year (Semester-I)/ Second Year (Semeter-III)	Session: 2025-26/ 2025-27
Subject: Industrial Microbiology			

1	Course Code	PC - 31	
2	Course Title	Industrial Production processes	
3	Course Type (Core Course)	Practical course	
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours level degree programme/ PG first year.	
5	Course Learning outcomes (CLO)	On completion of this course, learners will be able to learn: • for handling various advanced Fermentation techniques and the knowledge gained will help them to get a job in Industries/ laboratories based on fermentation technology. • Students will also learn applied aspects of processes and other techniques.	
6	Credit Value	04	
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40

Part B- Content of the Course

Total No. of Lectures-Tutorials-Practical (120 hours):
L-T-P:

Practical	Topics	Hrs
Industrial Production processes	1. Immobilization of enzyme using calcium alginate method. 2. Immobilization of enzyme using glass beads methods. 3. Microbial production of ethyl alcohol using Baker's yeast. 4. Study of microbial fermentation processes by choosing a specific microorganism and optimize fermentation condition to enhance the production of target product, such as lactic acid or a specific enzyme. 5. Study of microorganism used in industrial production of antibiotics 6. Perform solid state fermentation for cellulose production. 7. Screening of microorganism which utilize specialized nitrogen sources. 8. Screening of microorganism which utilize specialized carbon sources. 9. Isolation and study of microorganism used in, amino acid production. 10. Isolation and study of microorganism used in, vitamin production. 11. Isolation and study of microorganism used in solvent production. 12. Isolation and study of microorganism used in steroid production. 13. Isolation and study of microorganism used in fragrance industry. 14. Isolation and study of microorganism used in vaccines productions. 15. Isolation and study of microorganism used in organic acid production. 16. Isolation and identification of bacteria, yeast and fungi from bakeries and fermenters of distilleries. 17. Isolation and identification of different types of fungi and bacteria from curd, rotten fruits and vegetables. 18. Observation of the antagonism of three antibiotics against common plant pathogens in Petri plates (disc methods). 19. Demonstration of fermentation by using yeast. 20. Isolation of industrially important microorganisms from different environment. 21. Perform modules related virtual lab experiments from different web labs.	120

Keywords/Tags: *Fermentation, Industrial production, antagonism, enzymes.*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Analytical techniques: Holme and Peck
2. Analytical Instrumentation handbook: Jack Gazes, CRC press
3. Analytical techniques in Biochemistry and Molecular biology: R Katoch
4. Biological Instrumentation and methodology: PK Bajpai
5. Manual industrial Microbiology and Biotechnology-Richard H Baltz, Arnold Demain and Jullian Edward.
6. Principles of Fermentation Technology- Peter F Stan bury, AlenWhitaker and Stephen J hall.
7. Introduction to Industrial Microbiology by k Sukesh.
8. Principle and Application of Fermentation Technology- Aridam Kula &Vinay Sharma.
9. Enzyme Technology—Ashok Pandey, Colin Webb, Carlos Richard.
10. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford:
2. Suggestive digital platforms web links\ https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Class Interaction /Quiz	**10**	**Viva Voce on Practical**	**10**
Attendance	**10**	**Practical Record File**	**10**
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	**20**	**Table work / Experiments**	**40**
TOTAL	**40**		**60**

Any remarks/ suggestions:

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG programme/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-I)/ Second Year (Semeter-III)	Session: 2025-26/ 2025-27
Subject: Industrial Microbiology				
1	Course Code	CC - 32		
2	Course Title	Bioprocess Technology and Biosafety		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours/ research level degree programme/ PG first year.		
5	Course Learning outcomes (CLO)	On successfully completing the module, students will be able to demonstrate a knowledge and understanding of: • Select industrially important microbes for economical use including protein and other products. • Commercialization of any inventions in the biotechnology sector. • Concept of Biosafety regulations in development and handling of recombinant microbial products.		
6	Credit Value	06		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Part B- Content of the Course		
Total No. of Lectures- (90 hours): **L-T-P:**		
Unit	**Topics**	**No. of Lectures (in Hrs)**
I	1.1 The Ancient Bhartiya Gyan Parampara in medicinal and microbiological sciences with reference to Vedic texts. 1.2 Upstream strategies: Batch culture, Elemental balance equations, metabolic coupling – ATP and NAD+, yield coefficients, unstructured models of microbial growth, structured models of microbial growth. 1.3 Kinetics of media sterilization, Design of batch and continuous sterilization processes. 1.4 Calculation of Del factor and holding time. Richard's rapid methods of design of sterilization process. 1.5 Preparation of seed bank and inoculums.	**18**
II	2.1 Down stream strategies: Removal of microbial cells and other solid matter, Formation of foam. Separation and removal. 2.2 Estimation of products from foam. 2.3 Downtream. Precipitation, Filtration, centrifungation, cell disruption, liquid-liquid extraction, solvent recovery, 2.4 Two phases extraction, Reversed micelle extraction, supercritical fluid extraction. 2.5 Final purification: drying; crystallization; storage and packaging.	**18**
III	3.1 Bioprocess economics. Bioproduct regulation. General fermentation economics. 3.2 Biomass resources, renewable feed stocks, agro lignocellulosic residual material for valorization. 3.3 Circular economy and sustainable development goals. 3.4 Life cycle assessment of biodiesel, biofuel, biosurfactant production from microorganisms, algae. 3.5 Effluent treatment and recovery of by products. Disposal of effluents and dissolved oxygen concentration as an indicator of water quality.	**18**

IV	4.1 Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards. 4.2 biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals. 4.3 Definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; environmental risk assessment and food and feed safety assessment. 4.4 Risk assessment of transgenic crops *vs* cisgenic plants or products derived from RNAi, genome editing tools. 4.5 International regulations – Cartagena protocol,	**18**
V	5.1 OECD consensus documents and Codex. 5.2 Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies. 5.3 Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments and field trails. 5.4 Standard operating procedures (SoPs)- guidelines of state governments. 5.5 GM labeling – Food Safety and Standards Authority of India (FSSAI).	**18**

Activities:

- *Preparation of bio-products used in daily life*
- *Preparation power point presentation related to modules.*
- *Industrial visit/ field visit to observe mass scale production of microbial culture*
- *Preparation of charts and models related to modules*
- *Registration of Virtual labs for activities related to modules from different web labs.*

Keywords/Tags: *Vedic text, batch, continuous culture, Biosafety, Biosecurity.*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Doran Pauline (1995) Bioprocess Engineering Principles, Academic Press.
2. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering:
3. Systems, Equipment and Facilities, John Wiley andSons Inc.
4. Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2ndEd. Cambridge Univ. Press.
5. Operational Modes of Bioreactors, (1992) BIOTOL series, Butterworths Heinemann.
6. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
7. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology.
8. Oxford: Pergamon Press. Blanch, H. W., & Clark, D. S. (1997).
9. Biochemical Engineering. New York: M. Dekker.

2. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

Syllabus of Practicum Course

Part A Introduction			
Program: 1 year PG programme/ 2 year PG Programme	**Class`: M Sc**	**Year: First year (Semester-I)/ Second Year (Semeter-III)**	**Session: 2025-26/ 2025-27**
Subject: Industrial Microbiology			

1	**Course Code**	**PC - 32**	
2	**Course Title**	**Bioprocess Technology and Biosafety**	
3	**Course Type (Core Course)**	**Practical course**	
4	**Pre-requisite (if any)**	**To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours level degree programme/ PG first year.**	
5	**Course Learning outcomes (CLO)**	**On completion of this course, learners will be able to learn:** • **Basic fermentations processes, design of various fermenters and their types.** • **Different separation techniques and application of fermentation in waste treatment.** • **And select industrially important microbes for economical use including protein products.** • **the economics of the fermentation for the total cost of production.** • **Concept of Biosafety regulations in development and handling of recombinant microbial products.**	
6	**Credit Value**	**04**	
7	**Total Marks**	Max. Marks: 40+60	Min. Passing Marks:40

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (120 hours): **L-T-P:**		
Practical	**Topics**	**Hrs**
Bioprocess Technology and Biosafety	1. Deminstration of Batch fermentor and its part and functioning. 2. Deminstration of continuous fermentor and its part and functioning. 3. Demonstration of different fermentation bioprocess. 4. Upstream, processing for Antibiotics production. 5. Upstream processing for enzymes production. 6. Upstream processing for microbial biomass. 7. Calculations of substrates used in media for fermentation process. 8. Calculation of seed inoculum to different sizes of fermenters and purification strategies. 9. Downstream processing of different primary metabolites. 10. Downstream processing of secondary metabolites. 11. Bioeconomics and calculations involved in different fermentation steps. 12. Demonstration and calculation of Life cycle assessment in biotech industry for different products. 13. Life cycle assessment of biodiesel. 14. Life cycle assessment of biofuels. 15. Site survey to understand the effluent / waste treatment. 16. Water quality assessment of industrial effluents. 17. Study of Vedic text for use of microorganisms in medical sciences. 18. Biosurfactant isolation and its characterization (basic techniques). 19. Principle of biosafety cabinet and its classification. 20. Study of or visit to industry followed paramenters related to food and feed safety assessment. 21. Perform modules related virtual lab experiments from different web labs..	**120**
Keywords/Tags: *Fermentation, Bioprocess, Downstream, upstream processing.*		

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Systems, Equipment and Facilities, John Wiley andSons Inc.Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2ndEd. Cambridge
2. Univ. Press.Operational Modes of Bioreactors, (1992) BIOTOL series, ButterworthsHeinemann.Shuler, M. L., &Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper
3. Saddle River, NJ: Prentice Hall.Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology.
4. Oxford: Pergamon Press.
5. Shuler, M. L., &Kargi, F. (2002). Bioprocess Engineering: Basic Concepts.
6. Upper Saddle River, NJ: Prentice Hall.
7. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford:
8. Pergamon Press.
9. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering.New York: M. Dekker.
10. Bailey, J. E., &Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York:
11. McGraw-Hill.
12. Analytical techniques: Holme and Peck
13. Analytical Instrumentation handbook: Jack Gazes, CRC press
14. Manual industrial Microbiology and Biotechnology-Richard H Baltz, Arnold Demain and Jullian Edward.

2. Suggestive digital platforms web links\ https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Class Interaction /Quiz	10	Viva Voce on Practical	10
Attendance	10	Practical Record File	10
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	20	Table work / Experiments	40
TOTAL	40		60

Any remarks/ suggestions:

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG programme/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-II)/ Second Year (Semeter-IV)	Session: 2025-26/ 2025-27
Subject: Industrial Microbiology				
1	Course Code	CC - 41		
2	Course Title	Microbial Biotechnology		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours/ research level degree programme/ PG first year.		
5	Course Learning outcomes (CLO)	On completion of this course, learners will be able to learn: • Idea of recombinant DNA technology • About Cloning vectors • Gene libraries: cDNA and genomic libraries • Role of Mutagenesis in evolution of microbes • About general knowledge of Bioethics, Biosafety and IPR issues • PCR and Its application in DNA isolation from diverse sources, library formation • Forensic applications of VNTRs • Recombinant viruses as vaccines, Plants as edible vaccines and DNA vaccines		
6	Credit Value	06		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Part B- Content of the Course		
Total No. of Lectures- (90 hours): L-T-P:		
Unit	Topics	No. of Lectures (in Hrs)
I	1.1 Value addition in industrially important microorganisms using recombinant DNA technology; Basic techniques involved 1.2 Essential enzymes used in recombinant DNA technology 1.3 Cloning vectors; E coli vectors, Bacteriophage vectors, phasmids, shuttle vector, expression vectors. Selection and screening of recombinant genes. Cloning strategies. Cloning and selection of individual genes, gene libraries: cDNA and genomic libraries. 1.4 Design of vectors for the over expression of recombinant proteins: selection of suitable promoter sequences, fusion protein tags, protease cleavage sites and enzymes 1.5 Inducible expression systems; organelle specific expression of cloned gene.	18
II	2.1 Mutagenesis and directed evolution of microbes. 2.2 Different expression systems- Cloning in bacteria other than E. coli; cloning in Saccharomyces cerevisiae 2.3 Cloning in GRAS microorganism 2.4 Gene regulation- RNA interference: antisense RNA technology. 2.5 Bioethics, Biosafety and IPR issues.	18
III	3.1 Techniques in Microbial Biotechnology: Isolation of industrially important microorganism from different sources using specific substrates 3.2 Design and Preparation of Media for Bioprocesses; Growth curve studies of bacteria/Yeasts in batch culture and calculation of maximum specific growth rate; 3.3 Methods of biomass measurement; Production of ethanol from sucrose by yeast; Determination of yield coefficient and Monod's constant and metabolic quotient of E. Coli culture on glucose.; 3.4 Design of various fermenter and their working; 3.5 Production of citric acid using sucrose and molasses; Production of extracellular enzymes; Ethanol production using immobilized yeast culture	18

IV	4.1 PCR methods, PCR optimization, PCR cloning, real-time PCR, and PCR application in diagnostics 4.2 DNA sequencing methods. In vitro mutagenesis of cloned gene. 4.3 Genomics basic concepts. Functional genomics, structural genomics, comparative genomics and population genomics, CRISPR technology 4.4 Proteomics- basic concept and importance. 4.5 Metagenome: DNA isolation from diverse sources, library formation, screening of clones: functional screening, sequence based and high-throughput screening.	18
V	5.1 Nucleic acid sequences as diagnostic tools: 5.2 Detection of sequences at the gross level, single nucleotide polymorphisms (SNPs), importance of SNPs, forensic applications of VNTRs. 5.3 New drugs and new therapies for genetic diseases: recombinant proteins for therapeutic use. 5.4 Recombinant bacterial vaccines, Recombinant viruses as vaccines, Plants as edible vaccines, DNA vaccines, selecting targets for new antimicrobial agents 5.5 In vivo expression technology (IVET), and signature-tagged mutagenesis.	18

Activities:

- *Quiz competition of various aspect of recombinant DNA technology.*
- *Listing charts of different Industrial production processes by using microorganism.*
- *Industrial visit/ Scientific lab/ field visit to observe different types of Industrial production processes.*
- *Preparation of charts and models related to Microbial Biotechnology.*
- *Registration of Virtual labs for activities related to modules from different web labs.*

Keywords/Tags: *Cloning ,Mutagenesis, PCR , VNTRs, DNA vaccines*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1 .Rigden DJ, Fernández XM. The 2021 Nucleic Acids Research database issue and the online molecular biology database collection. Nucleic Acids Res. 2021 Jan 8;49(D1): D1-D9. doi: 10.1093/nar/gkaa1216. PMID: 33396976; PMCID: PMC7778882

2. Baxevanis, A. D., & Davison, D. B. (2021). Current Protocols in Bioinformatics. John Wiley & Sons.

3. Lesk, A. (2019). Introduction to Bioinformatics (5th ed.). Oxford University Press.

4. Rastogi, S., Mendiratta, N. and Rastogi, P., 2013. Bioinformatics methods and applications. Dehli, India: PHI Learning Private Limited.

5. Mandoiu, I., & Zelikovsky, A. (2016). Computational Methods for Next Generation Sequencing Data Analysis. Wiley.

6. Molecular Genetics of Bacteria: Snyder &Champness

7. Molecular Biology by Freifelder

8. Genomes 3: T. A. Brown

9. Principles of gene manipulation by Old and Primerose

10. Topic related recent review articles

2. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

Syllabus of Practicum Course

Part A Introduction			
Program: 1 year PG programme/ 2 year PG Programme	Class`: M Sc	Year: First year (Semester-II)/ Second Year (Semeter-IV)	Session: 2025-26/ 2025-27
Subject: Industrial Microbiology			

1	Course Code	PC - 41	
2	Course Title	Microbial Biotechnology	
3	Course Type (Core Course)	Practical course	
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours level degree programme/ PG first year.	
5	Course Learning outcomes (CLO)	On completion of this course, learners will be able to learn: • and handle various advanced Fermentation techniques and the knowledge gained will help them to get a job in Industries/ laboratories based on fermentation technology. • Students will also learn applied aspects of processes and other techniques.	
6	**Credit Value**	**04**	
7	**Total Marks**	Max. Marks: 40+60	Min. Passing Marks:40

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (120 hours): L-T-P:		
Practical	Topics	Hrs
Microbial Biotechnology	1. Use of Industrially important microorganisms in recombinant DNA technology 2. Basic techniques involved; potential enzymes used in recombinant DNA technology 3. Demonstration/ screening of cloning vectors studied by you. 4. Cloning strategies used in Recombinant DNA technology. 5. Bacteriophage used as cloning vector: Justify by performing an experiment. 6. Cloning and selection of individual genes using various antibiotics. 7. Design of vectors for the over expression of recombinant proteins. 8. Selection of suitable promoter sequences. 9. Perform experiment showing prototroph by using selective media. 10. Perform experiment showing auxotroph by using selective media. 11. Study/ perform experiments on protease cleavage sites and enzymes 12. Inducible expression systems; organelle specific expression of cloned gene. 13. Drug design case studies using Autodock, 14. Demonstration of Discovery Studio, Cresset 15. Identification of various pathogenic viruses with the help of electron microphotographs. 16. Isolation of mutant strain of microorganisms by using chemical mutagen. 17. Isolation of mutant strain of microorganisms by using UV radiation mutagen. 18. Isolation and purification of DNA from bacterial culture. 19. Identification of bacterial/ viral mutants from given culture. 20. Extraction of DNA in the virtual lab experiment from different web labs. 21. NCBI (Nucleotide, Gene, Protein, Pubmed, PubChem, etc.) a. Expasy: UniprotKB/Swissprot, PROSITE b. Introduction to Linux command line c. NCBI BLAST(different types) , N-W, S-W d. EBI: BLAST, ClustalW 22. NGS framework (e.g,. Galaxy) and use on any ChiP-seq and RNAseq sample datasets 23. Perform modules related virtual lab experiments from different web labs.	120
Keywords/Tags: *Cloning, auxotroph, prototroph, recombinant protein.*		

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Principles of gene manipulation by Old and Primerose
2. Genomes 3: T. A. Brown
1. Analytical techniques: Holme and Peck
2. Analytical Instrumentation handbook: Jack Gazes, CRC press
3. Biological Instrumentation and methodology: PK Bajpai
4. Manual industrial Microbiology and Biotechnology-Richard H Baltz, Arnold Demain and Jullian Edward.
5. Principles of Fermentation Technology- Peter F Stan bury, AlenWhitaker and Stephen J hall.
6. Introduction to Industrial Microbiology by k Sukesh.
7. Principle and Application of Fermentation Technology- Aridam Kula &Vinay Sharma.

2. Suggestive digital platforms web links\

https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Class Interaction /Quiz	10	Viva Voce on Practical	10
Attendance	10	Practical Record File	10
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	20	Table work / Experiments	40
TOTAL	40		60

Any remarks/ suggestions:

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG programme/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-II)/ Second Year (Semester-IV)	Session: 2025-26/ 2025-27
Subject: Industrial Microbiology				
1	Course Code	CC - 42		
2	Course Title	Genomics, Bioinformatics and Biostatistics		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours/ research level degree programme/ PG first year.		
5	Course Learning outcomes (CLO)	On successfully completing the module, students will be able to demonstrate a knowledge and understanding of: • various biological databases (online as well as standalone versions) • know the need and methods to retrieve data from thesedatabases using various search engines • acquire basic knowledge of Linux commands, shell scripting • understand pairwise and multiple alignment algorithms and their uses • know different software for phylogenetic analysis and reconstruction of phylogenetic trees • get exposed to different NGS platforms, genome assembly algorithms, sequence alignment formats, tools for conversion from one format to another, etc. • get familiarized with various aspect of Biostatistics • Antibiotics types, range and production of different types of antibiotics. • Development and production of various kinds of vaccines, vitamins and proteins.		
6	Credit Value	06		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Part B- Content of the Course		
Total No. of Lectures- (90 hours): L-T-P:		
Unit	Topics	No. of Lectures (in Hrs)
I	1.1 Genomes: Size, physical structure, Molecular Mapping of Genome Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci 1.2 Southern and fluorescence in situ hybridization for genome analysis, Chromosome micro dissection and microcloning 1.3 Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes 1.4 Whole genome shotgun sequencing, NGS (Next Generation Sequencing) 1.5 General characteristics of bacterial genome, metagenomics.	18
II	2.1 Molecular phylogenetics - Concept and overview. 2.2 Distance-based methods (UPGMA & NJ), character-based methods (Maximum Parsimony). 2.3 Phylogenetic analysis algorithms and their tools, cladistics. Reliability of trees (bootstrap, jackknife, etc.). 2.4 Difference between phylogenetic tree and dendogram. Phylogenetic trees and their composition: Various types of phylogenetic trees. Trees to trees distances, similarity. 2.5 Construction of phylogenetic trees (PHYLIP) and identifying homologs.	18
III	3.1 Introduction and classification of different biological databases (primary and secondary). 3.2 Web-based bioinformatics resources, including NCBI, EXPASY, and others. 3.3 Biological literature databases such as Pubmed, Nucleic acid databases like GenBank, EMBL, DDBJ, Refseq, etc. and Protein databases, e.g., PDB, Uniprot, Swiss-Prot, etc.). 3.4 Databases of RNA sequences such a (miRBase, IncRNAdb, siRNA database, etc.), 3.5 Species and Biodiversity databases (NCBI Taxonomy database, etc.)	18

IV	4.1 Software handling, BLAST: finding scores an; Evalues; Sequence alignment, nucleotide restriction-site determination,; 4.2 Dendrogram making (both rooted and unrooted); gene prediction, 4.3 Primer and oligos development using different softwares; 4.4 Retrieval of gene, finding specific gene from whole-genome sequence; Developing protein structure using Ras Mol; 4.5 Finding hydrophobicity in protein sequence e.g. Kitte & Doolittle; Developing a vector map using a software.	18
V	5.1 Biostatistical Technique: Frequency distribution, graphical representation 5.2 Measures of central tendency: mean, median and mode. 5.3 Measures of dispersion: range, standard deviation 5.4 Test of Significance: large sample test –single mean and differences of two mean. Small sample test(t – test) Single mean and difference of two means, 5.5 Chi square test for goodness of fit. ANOVA: one way and two way classification.	18

Activities:

- *Quiz competition of various aspect of genomics, bioinformatics and biostatistics.*
- *Listing charts of different steps used in handling the software related to bioinformatics.*
- *Scientific lab visit to observe different types of genomic analysis*
- *Preparation of charts and models related to modules*

Keywords/Tags: *Genomes, BLAST, NCBI taxonomy, ANOVA*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Microbial genetics by Freifelder
2. Gene Cloning by T A Brown
3. Principles of gene manipulation by Old and Primerose
4. Genes IX Lewin 5. Molecular Biology of the Gene: Watson et al
1. Rigden DJ, Fernández XM. The 2021 Nucleic Acids Research database issue and the online molecular biology database collection. Nucleic Acids Res. 2021 Jan 8;49(D1): D1-D9. doi: 10.1093/nar/gkaa1216. PMID: 33396976; PMCID: PMC7778882
2. Baxevanis, A. D., & Davison, D. B. (2021). Current Protocols in Bioinformatics. John Wiley & Sons.
3. Lesk, A. (2019). Introduction to Bioinformatics (5th ed.). Oxford University Press.
4. Rastogi, S., Mendiratta, N. and Rastogi, P., 2013. Bioinformatics methods and applications. Dehli, India: PHI Learning Private Limited.
5. Mandoiu, I., & Zelikovsky, A. (2016). Computational Methods for Next Generation Sequencing Data Analysis. Wiley
6. Looney, S., 2002. Biostatistical methods. Totowa, N.J.: Humana Press.
7. Le, C. T., & Eberly, L. E. (2016). Introductory biostatistics. Wiley
8. Wayne W. Daniel, Biostatistics: A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
9. Statistical methods – S P Gupta

2. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

Syllabus of Practicum Course

Part A Introduction			
Program: 1 year PG programme/ 2 year PG Programme	Class`: M Sc	Year: First year (Semester-II)/ Second Year (Semeter-IV)	Session: 2025-26/ 2025-27
Subject: Industrial Microbiology			

1	Course Code	PC - 42	
2	Course Title	Genomics, Bioinformatics and Biostatistics	
3	Course Type (Core Course)	Practical course	
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in Undergraduate Honours level degree programme/ PG first year.	
5	Course Learning outcomes (CLO)	On completion of this course, learners will be able to learn: • various advanced Fermentation techniques and the knowledge gained will help them to get a job in Industries/ laboratories based on fermentation technology. • Students will also learn applied aspects of processes and other techniques. • various biological databases (online as well as standalone versions) • know the need and methods to retrieve data from thesedatabases using various search engines • acquire basic knowledge of Linux commands, shell scripting • understand pairwise and multiple alignment algorithms and their uses • know different software for phylogenetic analysis and reconstruction of phylogenetic trees	
6	**Credit Value**	04	
7	**Total Marks**	Max. Marks: 40+60	Min. Passing Marks:40

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (120 hours): L-T-P:		
Practical	Topics	Hrs
Genomics, Bioinformatics and Biostatistics	1. Use bioinformatics tools for sequence analysis, transcription factor analysis, 2. RNA binding protein analysis, 3. Learning bioinformatics tools and techniques. 4. 3D diagram, bar diagram and line diagram using computer 5. Separation of macromolecules by electrophoresis 6. Plasmid DNA isolation and DNA quantization: Plasmid minipreps 7. Restriction digestion of DNA 8. Preparation of competent cells. 9. Transformation of *E. coli* with standard plasmids 10. Calculation of transformation efficiency 11. Cloning of genomic DNA in standard plasmid vectors 12. Miniprep of recombinant plasmid DNA 13. Restriction mapping 14. Polymerase Chain reaction using standard 16srRNA eubacterial primers 15. RFLP analysis of the PCR product 16. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. 3. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. 17. Diagrammatic/ graphical representation of data 18. Measure of central tendency 19. Measure of dispersion 20. Test of significance i (large/ small sample test) 21. Test of significance iii (chi-square test) 22. Bioinformatics Resources: NCBI, EBI, DDBJ, RCSB, ExPASy 5. BLAST BLASTn, BLASTp, PSI-BLAST 23. Multiple sequence alignment: Clustal W/ Clustal X and T-Coffee 8. Primer designing by primer 24. Phylogentic Analysis. 25. Protein Modeling and Protein structure Analysis, Docking 26. Sequence file formats: GenBank, FASTA, GCG, MSF 27. Perform modules related virtual lab experiments from different web labs.	120
Keywords/Tags: *Bioinformatics, plasmids, recombinant plasmics, protein modeling*		

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Biological Instrumentation and methodology: PK Bajpai
2. Manual industrial Microbiology and Biotechnology-Richard H Baltz, Arnold Demain and Jullian Edward.
3. Enzyme Technology—Ashok Pandey, Colin Webb, Carlos Richard.
4. Looney, S., 2002. Biostatistical methods. Totowa, N.J.: Humana Press.
5. Le, C. T., & Eberly, L. E. (2016). Introductory biostatistics. Wiley
6. Wayne W. Daniel, Biostatistics: A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
7. Statistical methods – S P Gupta

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Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

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TOTAL	40		60

Any remarks/ suggestions: